CLAIMS

1. An optical switching device formed from a substrate having a principal surface and comprising:

a deformable mechanical element extending in a direction parallel to said principal surface;

an optical element supported on said mechanical element and providing at least partial transmission therethrough of light incident thereupon into any of plurality of directions extending closer to a normal to said principal surface than parallel to said principal surface; and

an electrical control element controllably deforming said mechanical element and thereby selecting one of said plurality of directions.

2. The device of Claim 1, wherein said mechanical element includes a plate supporting said optical element and being supported on two torsion bars extending substantially parallel to said principal surface.

3. The device of Claim 1, wherein said electrical control element includes two electrodes with a void therebetween, one of said electrodes being fixed to said mechanical element.

4. The device of Claim 1, wherein said optical element is refractive.

5. The device of Claim 1, wherein said optical element is diffractive.

6. An assembly of a plurality of the devices of Claim 1 distributed in said principal surface of said substrate.

7. The assembly of Claim 6, wherein said plurality of devices are distributed two-dimensionally in said principal surface.

8. An assembly, comprising:

a first plurality of the devices of Claim 1 formed from a first one of said substrates and distributed in a plane of said first substrate; and

a second plurality of the devices of Claim 1 formed from a second one of said substrates and distributed in a plane of said second substrate;

wherein said first and second substrates are bonded together and allow a beam of light to be transmitted through optical elements on both of said substrates.

9. The assembly of Claim 8, wherein a position of a mechanical element on said first substrate through which said beam passes determines which of the mechanical elements on said second substrate said beam passes.

10. An optical switch, comprising:

a first substrate having formed therein a first plurality of optical switching elements; and

a second substrate having formed therein a second plurality of said optical switch elements optically associated with said first plurality of optical switching elements;

wherein each said optical switching element comprises

a deformable mechanical element extending in a direction parallel to a principal surface of a corresponding one of said substrates and deformable in a direction perpendicular to said principal surface,

an optical element supported on said mechanical element and providing at least partial transmission therethrough of light incident thereupon into any of plurality of directions extending closer to a normal to said principal surface than parallel to said principal surface, and

an electrical control element controllably deforming said mechanical element and thereby selecting one of said plurality of directions.

11. The optical switch of Claim 10, wherein said two substrates are bonded together with said switching elements of said first substrate face said switching elements of said second substrate.

12. The optical switch of Claim 10, wherein said each mechanical element includes a plate supporting said optical element and being rotatably supported by two torsion beams.

13. The optical switch of Claim 10, wherein said optical elements are refractive.

14. The optical switch of Claim 10, wherein said optical elements are diffractive.

15. A method of manufacturing an optical switch, comprising the steps of:

a first step of fabricating in a first substrate an array of a plurality of optical switching elements;

a second step of fabricating in a second substrate an array of a plurality of optical switching elements; and

bonding together said substrates so that the switching elements of said two substrates face each other;

wherein each of said optical switching elements includes

a deformable mechanical element,

an electrical control element controlling an angular orientation of said mechanical element, and

an transmissive optical element supported on said mechanical element and allowing passage of light between said two arrays of switching elements.

16. The method of Claim 15, wherein said bonding step is performed after said two fabricating steps.

17. The method of Claim 15, wherein said bonding step is performed between said two fabricating steps.

18. The method of Claim 15, wherein said two fabricating steps micro electromechanical fabricating techniques.

19. The method of Claim 18, wherein said techniques include lithography, etching, and at least one of sputtering and chemical vapor deposition.